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STACK-UNIT MAPPING OF GEOLOGIC MATERIALS IN ILLINOIS TO A DEPTH OF 15 METERS

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CIRCULAR 542

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ABSTRACT

A stack-unit map shows the distribution of earth materials vertically from the surface to a specified depth and horizontally over a specified area. It also shows the succession of geologic units in their order of occurrence within the specified depth. This information is now available for the entire state of Illinois with the publication of the statewide stack-unit map of geologic materials to a depth of 15 meters (49.3 ft). The statewide stack-unit map, which is made up of four separate, regional maps, provides basic geologic information for interpretive mapping for regional, resource-based land-use planning and decision making.

INTRODUCTION

This circular accompanies the stack-unit map (Plates 1-4) for the state of Illinois to a depth of 15 meters (49.3 ft). The purpose of this circular is to summarize the steps in the creation of the map, define the mapping parameters and conventions used specifically in this map, and suggest additional uses for it. More information on stack-unit mapping or other areas mentioned in this circular is available from those sources listed in the references.

A stack-unit map is a particular way of representing geological data to show the distribution of earth materials vertically from the surface to a specified depth as well as horizontally over a specified area. Because it provides a three-dimensional picture of the geologic framework of an area, a stack-unit map is a basic reference for a variety of applications. The stack-unit map provides a foundation for interpretive maps for assessing potential for contamination from waste disposal sites; construction conditions; groundwater recharge capability for various terrains; shallow groundwater availability; and potential for mineral resources such as sand, gravel, dolomite, limestone, or near-surface deposits of coal. The identification, description, and mapping of both vertical and horizontal distribution of geologic materials makes possible the evaluation of the potential uses of any material or sequence of materials. Based on this mapping, the sequences of materials can then be rated for a variety of land uses. This rating makes it possible to take advantage of materials that meet a particular resource need, while avoiding those materials that may pose problems.

Much of the data for this stack-unit map was collected as part of a mapping project sponsored by the Illinois Environmental Protection Agency. The purpose of that project was to map the potential for contamination of shallow aquifers in Illinois by describing and mapping geologic materials to a depth of 15 meters throughout the state. The principal products of that project were interpretive maps showing contamination potential (Berg, Kempton, and Cartwright, 1984). In addition to the data available from this project, the stack-unit map presented here is a compilation of statewide surficial geologic information and data on subsurface material including that from the logs of over 25,000 water wells and test borings. Information presented on this stack-unit map updates portions of statewide maps of Quaternary deposits (Lineback, 1979) and of drift thickness (Piskin and Bergstrom, 1975).

The statewide stack-unit map comprises four separate plates. Each plate is a map of a region of the state. By dividing the statewide stack-unit map into four separate regions, it was possible to maintain readability and a usable size consistent with a scale of 1:250,000, where one inch = four miles (6.4 km).

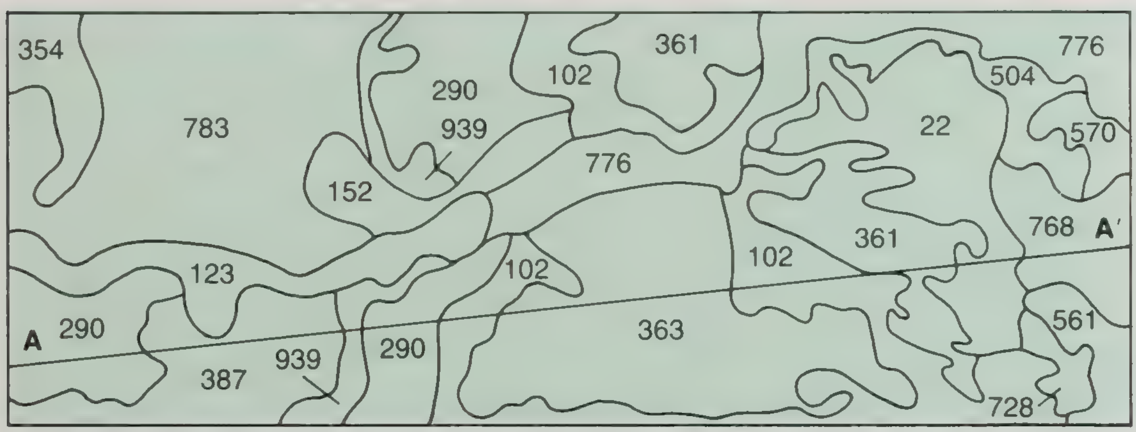
More than 5000 individual map areas make up the statewide map, and some of these areas are less than one square kilometer. An alphanumeric coding system was designed that could describe the geologic materials and yet fit within the small mapping areas.

Previous stack-unit maps have focused on local, county, or regional needs, and have been limited to sequences of 6 meters (19.7 ft) or less. This statewide stack-unit map of materials to a depth of 15 meters provides a resource for statewide land-use planning, mineral resource assessment, groundwater location, and other environmental issues.

CONSTRUCTION OF STACK-UNIT MAPS

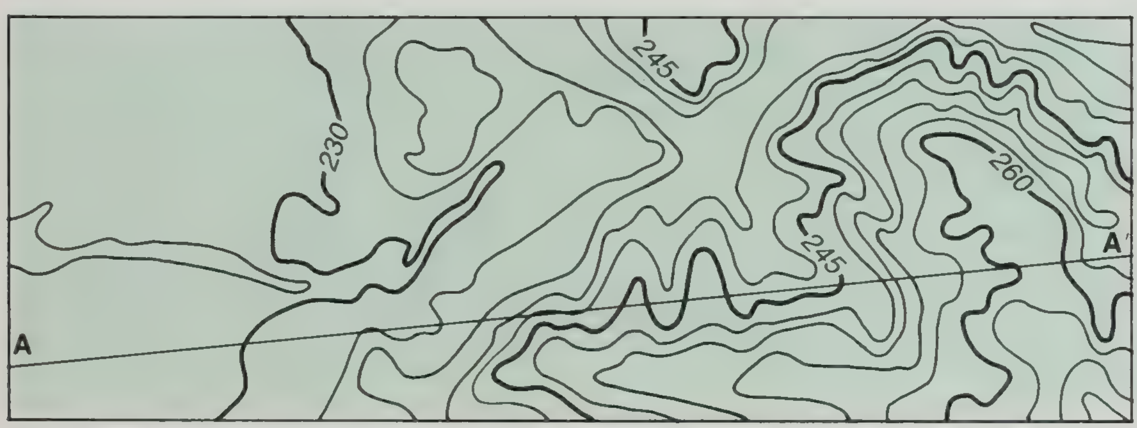
Constructing a theoretical stack-unit map is detailed in Kempton (1981). Information on constructing stack-unit maps is also available in Berg, Kempton, and Stecyk (1984), and Berg, Kempton, and Cartwright (1984). The specific steps in constructing the statewide stack-unit map to a depth of 15 meters (49.3 ft) are summarized here as follows:

> Geologic information for the upper 1.5 meters (5 ft) was compiled from existing maps such as the U.S. Department of Agriculture, Soil Conservation Service maps (McComas, Hinkley, and Kempton, 1969) (fig. 1a), U.S. Geological Survey topographic maps (fig. 1b) and the map of Quaternary Deposits of Illinois by Lineback (1979). Where detailed surficial maps were not available, the original data compiled for the state surficial deposits map (Lineback, 1979) were used.



22, 728 — Paleosol in till soils
102, 570 — Colluvial soils
123, 152, 776 — Alluvial soils
290, 354, 387, 783, 939 — Outwash soils
361, 363 — Till soils
504, 561, 768 — Bedrock soils

1a



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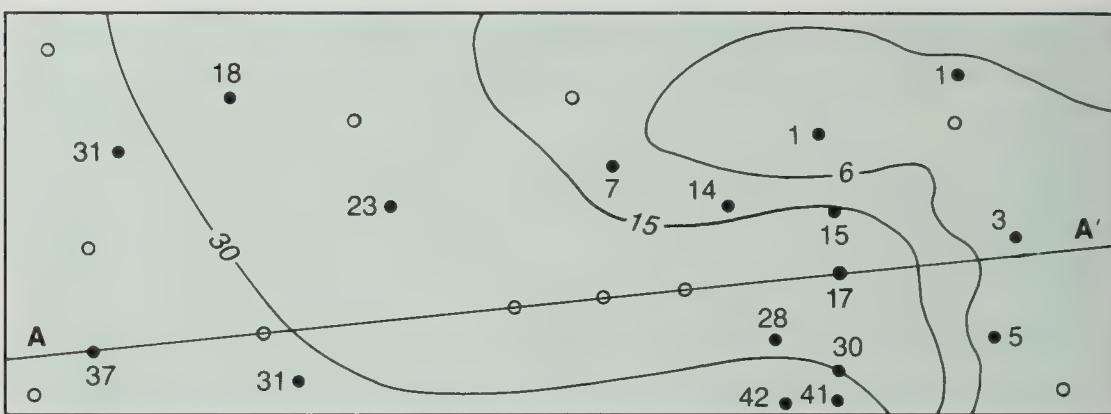
Contour interval 3 m

1b

Figure 1a, 1b Initial steps i... constructing the statewide stack-unit map required ... piling data from a variety ... sources such as the U.S.D.A. Soil Conservation Servic... maps (1a) onto U.S. Geo... ca Survey topograph... (1b). Figure 1d show... section A-A′ (Modified ... Berg, Kempton, and Cartwright, 1984)

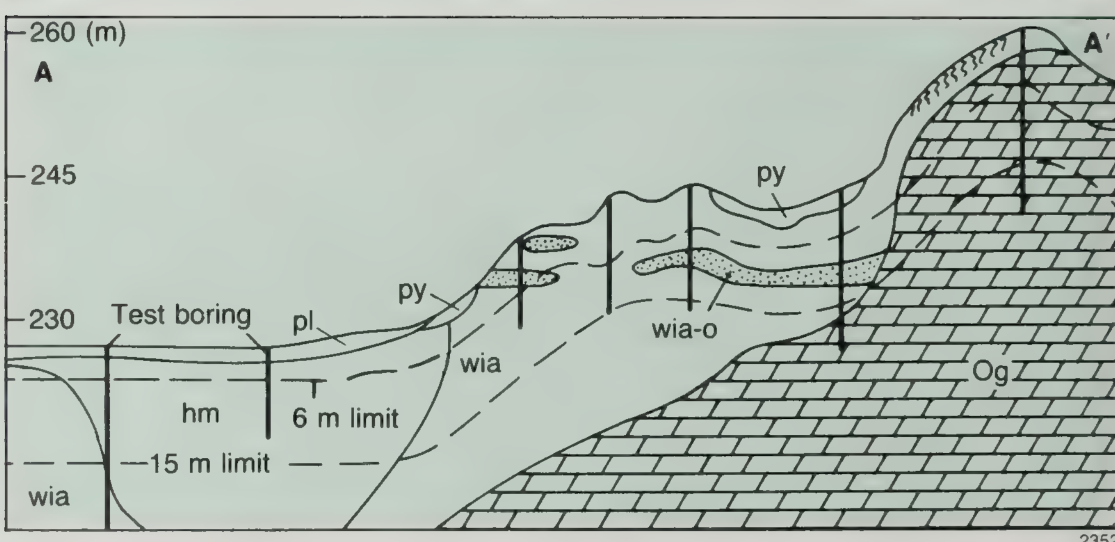


1c

• Boring depths to bedrock
○ Shallow borings

Drift thickness and stratigraphic units were plotted onto topographic base maps (fig. 1c) using data from geologic reports and maps, field observations, water well logs and samples, engineering boring logs and core samples, and from controlled drilling for various projects. Physical and mineralogical properties from the various geologic units were compiled. Where possible, data on surficial units were checked against soil maps.

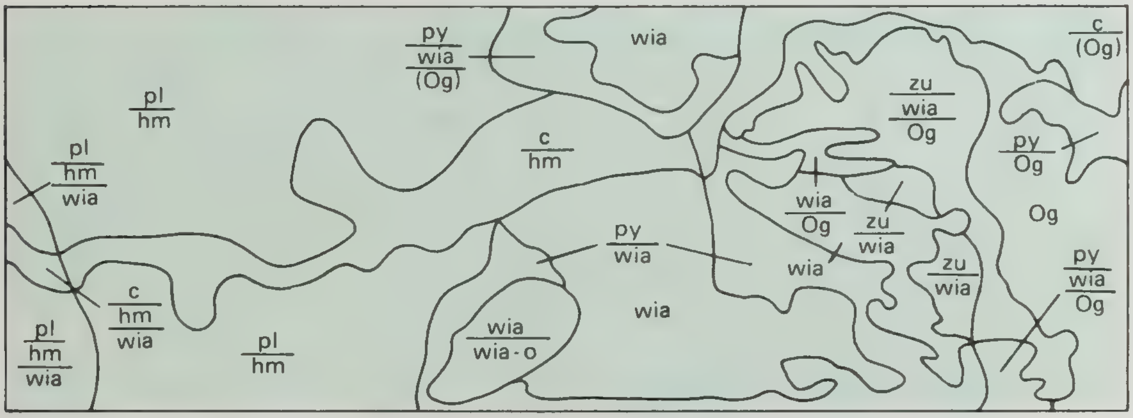
Cross sections (fig. 1d) were constructed in some areas to help identify the continuity of subsurface materials.



1d

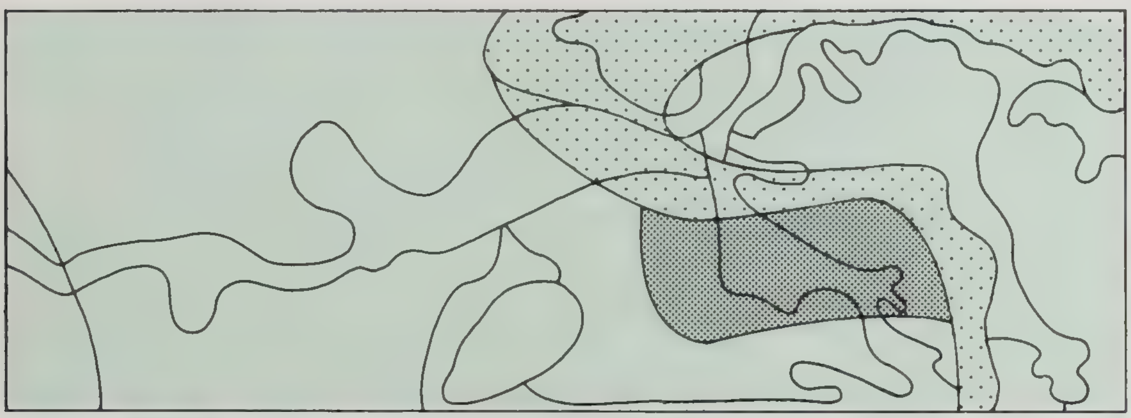
Surficial mapping data, including stack-unit data to a depth of 6 meters (19.7 ft) (fig. 1e), were added to the base map from several published or unpublished maps.

Subsurface geologic data between 6 and 15 meters (19.7 and 49.3 ft) (fig. 1f) were determined from existing detailed subsurface studies or from well logs, sample set descriptions, geologic investigations, field notes and test drilling.



c — alluvium
hm — outwash sand and gravel
Og — jointed and permeable bedrock
pl — eolian sand
py — colluvium
wia — sandy till
wia-o — buried outwash below till
zu — paleosol

1e



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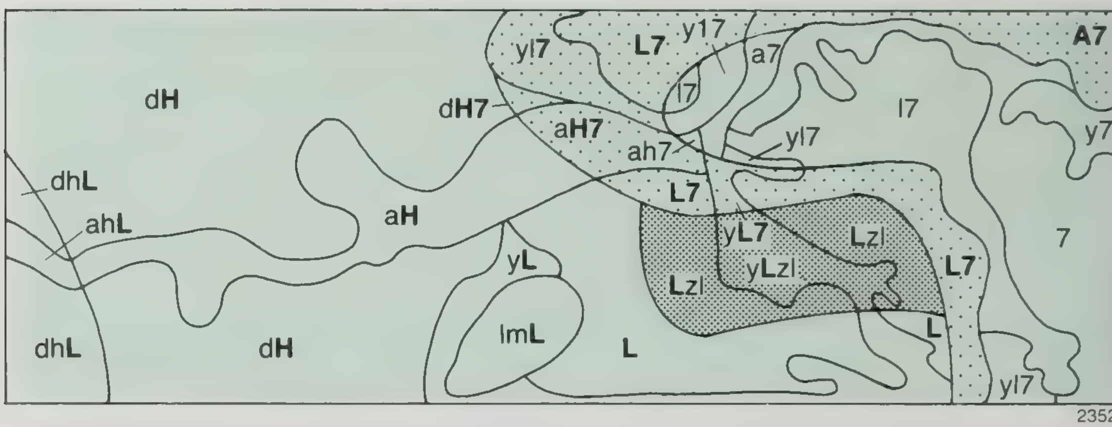
Sand and gravel 6 to 15 m below surface

Bedrock 6 to 15 m below surface

1f

Combining shallow stack-unit data with deeper subsurface data produced a stack-unit map to a depth of 15 meters (fig. 1g); an alphanumeric coding system has been used to describe the character, thickness, and age of materials in their sequence of occurrence.



>6 m thick	<6 m thick	Drift
A	a	Cahokia Alluvium
	d	Parkland Sand
	y	Peyton Colluvium
H	h	Henry Fm.
L	l	Winnebago Fm. diamicton
	m	Winnebago Fm. sands and gravels within 6m of surface
	z	Glasford Fm. sands and gravels between 6 and 15m of surface

>6 m below surface	<6 m below surface	Bedrock
7	7	Ordovician System, dolomite

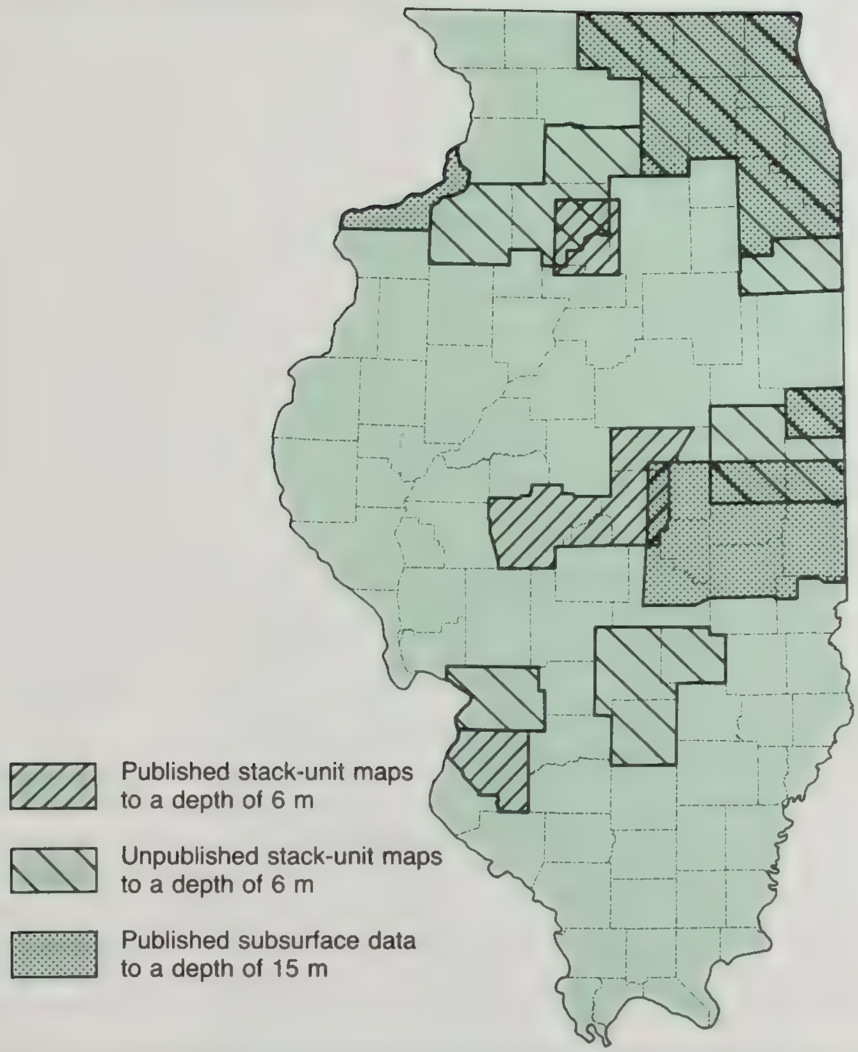
1g

Figure 1g The statewide [illegible]tack-unit [illegible] a depth of 15 [illegible] (49 [illegible] ft) [illegible] compila- [illegible]data from many sources [illegible] describe the geologic [illegible] within the areas [illegible]

Additional Sources of Data

Stack-unit maps, available for several regions in Illinois (fig. 2), were used for information on materials within 6 meters of surface, or, in some cases, to 15 meters. In regions for which these maps were not available, well logs and sample set descriptions were studied to determine the stacked sequences of materials below 6 meters (19.7 ft).

The Geologic Map of Illinois (Willman, 1967) and more recent investigations by Willman and Kolata (1978) and Kolata and Graese (1983) were used to determine the distribution of bedrock materials. New well logs provided information that revised parts of the drift thickness map of Illinois (Piskin and Bergstrom, 1975), particularly in west-central Illinois from Rock Island County in the north to Calhoun and Jersey Counties in the south. The 15-meter (49.3 ft) thickness contours established by Piskin and



Bergstrom were used throughout central and south-central Illinois in those areas underlain by Pennsylvanian-age shale and limestone and where updated maps were not available.

In general, both the availability and reliability of data decrease with depth. Thus, map units within 6 meters of the surface are likely to be more accurate than those below 6 meters because more and better information is available for this shallower interval where most land-use activity occurs. Data in the 6- to 15-meter interval were determined primarily from water well and test well data. The density of data varies considerably depending on the location in the state. Fewer subsurface data are available in west-central Illinois outside areas of coal and oil exploration and residential expansion. The greatest concentration of subsurface data is in highly urbanized northeastern Illinois and in areas of oil and coal exploration in the southern third of Illinois.

Stack-Unit Mapping Parameters

The selected depth (15 m or 49.3 ft) of the statewide stack-unit map is partially the result of the original purpose for which the geologic data were collected—to determine the potential for contamination of shallow aquifers from burial of municipal wastes (Berg, Kempton, and Cartwright, 1984). Land burial of municipal waste commonly occurs in trenches about 6 meters deep, and 9 meters (30 ft) of relatively impermeable material should underlie the base of the landfill trench to protect aquifers deeper than 15 meters. Within this 15-meter depth, the initial study separated unconsolidated material into those greater than or less than 6 meters (19.7 ft) thick. Bedrock was also separated into two categories: less than 6 meters below the surface, or between 6 and 15 meters of the surface. This 6-meter depth was also part of the original study's design because detailed stratigraphic data are essential in the upper 6 meters to map those materials susceptible to contamination by surface and near-surface wastes.

The minimum thickness mapped was 1.5 meters (5 ft) except where a continuous unit less than 1.5 meters was traced over at least one square kilometer. The statewide stack-unit map is made up of 5,199 individual map areas or polygons. A total of 815 different combinations of geologic units are mapped, and most of these contain two or three materials. Data were first plotted onto 1:62,000- or 1:24,000-scale topographic quadrangle maps and then transferred to maps at a scale of 1:250,000. Some units were combined or generalized because they were spatially variable and difficult to map from the 1:24,000 or 1:62,500 map scales. Areas that were near map-unit boundaries or that contained a complex sequence of materials were often difficult to map accurately because some geologic deposits grade into each other or wedge out. The most accurate portions of the map are large areas interpreted as one geologic material or a sequence of similar materials thicker than 15 meters.

At a scale of 1:250,000, 6.4 kilometers (4 miles) is equal to one inch. By dividing the statewide stack-unit map into four separate regions (and four separate maps), it was possible to accommodate this large scale with maps that are readable and of a usable size (see fig. 3 for regions covered on each plate).

Alphanumeric Coding Of Materials

An alphanumeric coding scheme was designed (see tables 1 and 2) to accommodate small map areas (some less than one square kilometer) where traditional stack-unit symbols (as shown in fig. 1e) would not fit. A total of 30 different geologic materials are categorized—23 nonlithified mate rials, including Pleistocene deposits and semilithified Pliocene and Cretaceous sediments (table 1), and seven lithified bedrock types (table 2).

Nonlithified and semilithified materials are described by letters of the alphabet.

Boldface, uppercase letters represent materials greater than 6 meters (19.7 ft) thick.

Lowercase letters represent materials less than 6 meters thick.

Materials range in age from Holocene/late Wisconsinan (A-H,Y); Wisconsinan (I-K); Illinoian (L-R); pre-Illinoian (U); Pliocene (V); to Cretaceous (W). The letter Y refers to the Peyton Colluvium, which is a relatively small unit that is mappable only locally on a statewide scale.

Principal material types were differentiated within the Wedron, Winnebago, and Glasford Formations. Within the Wedron and Glasford Formations are two grain-size compositions of diamictons (mainly glacial tills)

Time-Stratigraphy	Alphanumeric Code		Quaternary Deposits Map*
	A	a	Cahokia Alluvium
	B	b	Richland Loess
	C	c	Peoria Loess and Roxana Silt
Holocene/	**D**	d	Parkland Sand
late	**E**	e	Grayslake Peat
Wisconsinan	**F**	f	Equality Fm, Carmi Mbr
	G	g	Equality Fm, Dolton Mbr
	Y	y	Peyton Colluvium
	H	h	Henry Fm
	I	i	Wedron Fm, silty and clayey diamictons
	J	j	Wedron Fm, loamy and sandy diamictons
Wisconsinan	**K**		Sand and gravel within Wedron Fm:
		k	within 6 m (19.7 ft) of surface
		z	between 6–15 m (19.7–49.3 ft) of surface
	L	l	Winnebago Fm, mainly sandy diamictons
	M		Sand and gravel within Winnebago Fm:
		m	within 6 m (19.7 ft) of surface
		z	between 6–15 m (19.7–49.3 ft) of surface
	N	n	Teneriffe Silt
Illinoian	**O**	o	Pearl Fm (includes Hagarstown Mbr)
	P	p	Glasford Fm, silty and clayey diamictons
	Q	q	Glasford Fm, loamy and sandy diamictons
	R		Sand and gravel within Glasford Fm:
		r	within 6 m (19.7 ft) of surface
		z	between 6–15 m (19.7–49.3 ft) of surface
Pre-Illinoian	**U**	u	Wolf Creek Fm (mainly diamictons)
Pliocene	**V**	v	Mounds Gravel and related units
Cretaceous	**W**	w	Cretaceous sediments, silts, sands, etc.
Miscellaneous	**X**		Surface mines/manmade land

NOTE: Boldface, uppercase letters represent materials greater than 6 meters (19.7 ft) thick; lowercase letters represent those materials less than 6 meters thick. Most diamictons are genetically glacial tills or derived from glacial tills.

*Lineback, J. A., 1979, Quaternary Deposits of Illinois: Illinois State Geological Survey map, scale 1:500,000.

Table 2 A

Alphanumeric Code		Geologic Map of Illinois Equivalent*
1	1	Pennsylvanian rocks, mainly shales
2	2	Pennsylvanian rocks, mainly sandstones
3	3	Mississippian rocks, mainly shales
4	4	Mississippian rocks, mainly limestones, some sandstones
5	5	Silurian and some Devonian rocks, mainly dolomite
6	6	Ordovician rocks, mainly shale (Maquoketa Group)
7	7	Ordovician and Cambrian rocks, mainly dolomite, some sandstone

NOTE: Boldface numerals represent materials greater than 6 meters (19.7 ft) below surface; numerals in regular typeface represent materials within 6 meters (19.7 ft) of surface. The thickness below 15 meters is undetermined for the lowest unit shown.

*Willman, H.B., 1967, Geologic Map of Illinois: Illinois State Geological Survey map, scale 1:500,000.

can be distinguished: silty or clayey and loamy or sandy. Within the Winnebago Formation, all diamictons are sandy; within the Wolf Creek Formation, the diamictons have not been differentiated. (See table 1 for letter codes for these formations.) There are unnamed but widespread buried or exhumed deposits of sand and gravel that are within 6 meters (19.7 ft) of the surface and stratigraphically between diamictons within formations. These materials are designated by the letter "k" in the Wedron Formation, "m" in the Winnebago Formation; "r" within the Glasford Formation. The letter "z" is used to designate any sand and gravel deposit between 6 and 15 meters (19.7 and 49.3 ft) of the surface regardless of the formation in which it occurs.

Because the Pliocene-Pleistocene Mounds Gravel and related deposits (V) and Cretaceous sediments (W) have hydrogeologic and engineering properties that are similar to those of drift materials, they are not grouped with the bedrock materials. Both are present in restricted portions of the state.

The letter "X" is used to designate areas of disturbed materials such as strip mine land, or manmade land. Geologic data in surrounding map areas indicate the materials that make up this disturbed land.

Lithified materials (bedrock units) are designated by numbers 1 through 7 (table 2).

Boldface numerals identify bedrock units occurring between 6 and 15 meters (19.7 and 49.3 ft) of the surface.

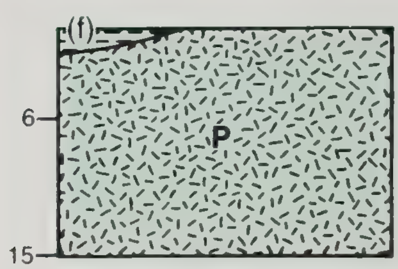
Numerals in regular type identify bedrock units within 6 meters of the surface.

The time stratigraphy is suggested by the sequence: 1 (shale or dense limestone) or 2 (sandstone) for Pennsylvanian bedrock; 3 (shale) or 4 (limestone or sandstone) for Mississippian bedrock; 5 (mainly dolomite) for Silurian and Devonian bedrock; 6 (shale) or 7 (dolomite and sandstone) for Ordovician bedrock. Ordovician and Pennsylvanian carbonates are separated because the Ordovician carbonates are commonly more fractured than Pennsylvanian carbonates.

Use of Parentheses

The use of parentheses in this map differs slightly from previous usage (Kempton, 1981). In general, parentheses are used to indicate some kind of discontinuity, but there are several variations for both nonlithified and semilithified materials (letter codes) and bedrock units (number codes). The variations are explained below, and figures 4 and 5 provide graphic descriptions of each case.

Parentheses around lowercase letters, which represent unconsolidated materials less than 6 meters (19.7 ft) thick, suggest that

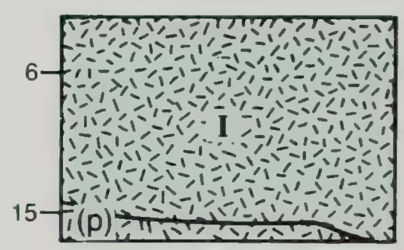


(f)**P**

Equality Carmi silts <6 m thick and discontinuous overlying >6 m of fine-grained Glasford Formation diamicton.

Parentheses around lowercase letter (unconsolidated material) indicate material is not continuous throughout map area. Underlying material is principal map unit.

4a



I(p)

Generally >15 m of fine-grained Wedron Formation diamicton overlying fine-grained Glasford Formation diamicton at or near the 15-m depth.

Parentheses around lowest unit indicate that unit may not be present above the 15-m depth, but is generally present at or just below 15 m.

4b

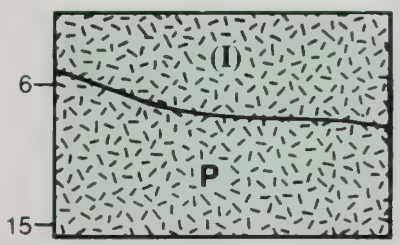
Figure 4 Examples of the [illegible] parentheses with stack-[illegible] on nonlithified [illegible] materials.

the enclosed material is not continuous throughout the map area and that the underlying material is the principal map unit (fig. 4a).

Parentheses around the lowest unit suggest that the unit may not be present above the 15-meter (49.3 ft) depth, but generally lies at or just below 15 meters (fig. 4b).

Parentheses around uppercase boldface letters, which designate materials greater than 6 meters (19.7 ft) thick, indicate that this material is present throughout the map area, but not consistently at a thickness of 6 meters or more (fig. 4c). If these materials are the lowermost unit in the sequence, parentheses may also suggest that the unit may not be present above the 15-meter depth, but generally lies at or just below 15 meters (fig. 4d). This last case, which is relatively rare, occurs only if the lowermost unit is strongly suspected to be more than 6 meters thick.

Parentheses around numerals (fig. 5a) indicate that the bedrock surface may be present above the 15-meter (49.3 ft) depth, but generally lies at or just below 15 meters.

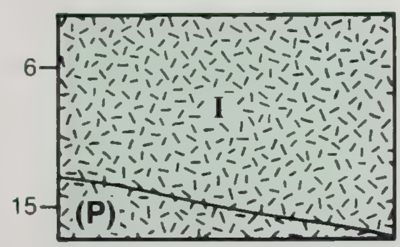


(I)P

Generally >6 m of fine-grained Wedron Formation diamicton overlying fine-grained Glasford Formation diamicton >6 m thick.

Parentheses around uppercase, boldface letter, which represents material greater than 6 m thick, indicate that the material is not present consistently at that thickness but is present continuously within the map area.

4c



I(P)

Generally >15 m of fine-grained Wedron Formation diamicton overlying a known >6-m thick fine-grained Glasford Formation diamicton at or near the 15-m depth.

When materials over 6 meters thick occur at the lowest unit in a sequence, then parentheses indicate that the unit may not be present above the 15-m depth, but is generally present at or just below 15 m.

4d

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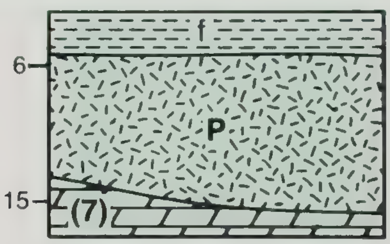
Parentheses around numerals (fig. 5b) indicate that bedrock surface may not be continuous in the map area between depths of 6 and 15 meters (19.7 and 49.3 ft), but may be present within 6 meters (19.7 ft) of the surface over a portion of the map area. The thickness below 15 meters of the last unit shown is undetermined.

Regional information, drift thickness, and local data sources were used to determine the thickness of the lowermost nonlithified material. For bedrock units, the uppermost bedrock material was assumed to extend at least to the 15-meter depth limit. No attempt was made to differentiate changes in bedrock type beneath the uppermost designated bedrock unit.

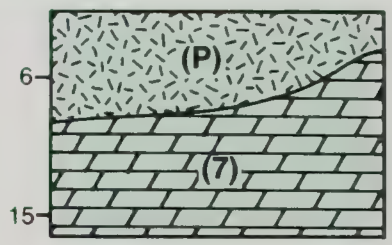


fP(7)

<6 m of Equality Carmi silts overlying >6 m of fine-grained Glasford Formation diamicton overlying Ordovician bedrock near the 15-m depth

Parentheses around numeral indicate that bedrock surface may be present above the 15-m depth but generally lies at or just below 15 m.

5a



(P)(7)

Generally >6 m of fine-grained Glasford Formation diamicton overlying Ordovician bedrock generally below the 6-m depth.

Parentheses indicate that bedrock surface may not be continuous in the mapping area between 6–15 m depth, but may be present within 6 m of the surface over a portion of the map area.

5b

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Figure 5 Examples of the use of parentheses with rock-unit symbols in lithified materials

USES OF STACK-UNIT MAPS

The general concept of a stack-unit map is that once the arrangement of geologic deposits is established within a framework of controls (data and geologic concepts), materials can be evaluated in terms of their industrial mineral resource potential and hydrogeologic and engineering properites. Because stack-unit maps are also stratigraphic maps, they can provide clues to many aspects of geologic history that occurred prior to events represented by surficial mapping. The uses of stack-unit maps are described in detail by Kempton (1981); other examples are given by Kempton and Cartwright (1984).

Depth is a significant factor for most resource and land-use interpretations derived from the stack-unit data presented in this circular. For example, in the evaluation of sites for municipal landfills, geologic materials to a depth of 15 meters should be documented. For near-surface or surficial waste-disposal practices, for evaluation of materials for shallow construction purposes, or assessment of recharge, detailed information in the upper 6 meters is usually the most important. For mineral resource evaluation, the thickness of overburden and thickness and character of the resource must be considered. Likewise, for shallow groundwater resource evaluation, the thickness, continuity, and depth of an aquifer, as well as the properties of overlying materials must be recognized.

Several interpretive maps derived from information on the statewide stack-unit map have already been published. General descriptions of these interpretive maps are included here, and detailed discussions of each are available in the publications listed.

Municipal Waste Disposal

Berg, Kempton, and Cartwright (1984) mapped 18 stack-unit sequences throughout the state. Each sequence (not specific materials) was rated for the susceptibility of its materials to contamination from municipal waste disposal. The capacities of the earth materials within the sequence to accept, transmit, restrict, or remove contaminants from waste effluents were the basis for the ratings. An important element in the construction of this map was the identification of any permeable material within 50 feet of the surface because sand and gravel or permeable bedrock aquifers within 50 feet of the surface are considered most susceptible to contamination. These sequences occur mostly in northern, northwestern, western, and extreme southern Illinois. Sequences with the lowest contamination potential contain either impermeable bedrock or uniform diamicton (mostly glacial till) or other fine-grained materials within 50 feet of the surface. These sequences cover much of northeastern and central Illinois.

Surface and Near-Surface Waste Disposal

They also mapped and evaluated 13 stack-unit sequences for the potential for contamination by septic systems, surface spreading of wastes, and land

application of fertilizers and pesticides. Critical to the construction of this map was geologic information within 20 feet of the surface because sand and gravel or permeable bedrock within 20 feet of the surface are the most susceptible to contamination at the surface. Uniform diamicton or other fine-grained materials or impermeable bedrock within 20 feet of the surface are the least susceptible to contamination. The former conditions occur principally in north-central, northwestern, and southern Illinois; the latter, in northeastern and central Illinois.

Shallow Aquifer Identification Le Seur (1985) evaluated regional infiltration by extracting portions of the stack-unit map locating sand and gravel aquifers as well as shallow bedrock aquifers. Information from the stack-unit map has also been used to delineate potential aquifers within 50 feet of the surface for preliminary statewide screening for the disposal of low-level radioactive waste (Miller et al., 1985).

Other Uses Stack-unit maps can be used to appraise regional geologic conditions. Site-specific studies can then be added to the stack-unit map database. A stack-unit map can be used to estimate engineering conditions for a site prior to facility construction (Kempton, 1981). In addition, the statewide stack-unit map can provide regional data for locating areas suitable for borrow pits, or for identifying general geologic conditions that might affect excavation and construction for roads, pipelines, or sewers.

The statewide stack-unit map can also provide information for locating mineral resources, particularly sand and gravel, clay, peat, and limestone or dolomite. Important factors are the thickness of overburden and the thickness and quality of the resource. The statewide stack-unit map, which includes individual unit thicknesses and depths to potential resources, could help to assess shallow industrial mineral resource capabilities on a regional basis and economic potential for sand and gravel and shallow limestone or dolomite. In most cases, on-site assessment, including test drilling, is necessary to evaluate a particular resource.

Kempton and Cartwright (1984) show that by combining a stack-unit map with physiographic elements, primarily topography, into a terrane map and applying hydrogeologic data and principles, interpretive maps can be constructed to depict regional groundwater recharge rates and estimated depth to the top of the zone of saturation (water table). The statewide stack-unit map may provide the basis for preparing a regional terrane map for hydrogeologic evaluations.

Statewide stack-unit data can be coordinated with U.S. Department of Agriculture, Soil Conservation Service soil maps. McComas, Hinkley, and Kempton (1969) and Kempton (1981) point out that using soils data to help map geologic data produces the most accurate maps of surficial materials.

Indeed, as described previously, several county and regional geologic maps were produced using soil maps; some of the original mapping was done by grouping soil series into respective parent materials. Therefore, the sequence of geologic units depicted on the stack-unit map may be compared with recent county soil maps.

The combination of the statewide stack-unit map data with local and regional soils data provides a basis for evaluation of land-use practices that can potentially result in groundwater contamination. Interpretations made from geologic data, particularly the assessment of contamination potential from surface and near-surface waste disposal, should include the adsorption capacity of surficial soil in reducing contaminants.

The ultimate utility of the geologic information depicted on the stack-unit maps depends upon the creativity of the user. This can be enhanced by the computerization of the regional database. At the Illinois State Geological Survey, a Geographic Information System (GIS) is used to store, organize, merge, and retrieve data. The system allows researchers to

- continually update the database as information feeds back from field work and laboratory analyses;
- map, compute, and analyze data relevent to each phase of a study, as it moves from regional to site specific;
- define a siting-study area through immediate access to a comprehensive base of regional data;
- successively refine the investigation through data integration and evalution (Hines, 1986).

Thus, geologic information from site-specific studies can be used to refine the regional stack-unit database. Updated stack-unit maps can be continually generated through this feedback process.

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REFERENCES

Anderson, R. C., 1980, Geology for planning in Rock Island County, Illinois: Illinois State Geological Survey Circular 510, 35 p.

Berg, R. C., J. P. Kempton, L. R. Follmer, and D. P. McKenna, 1985, Illinoian and Wisconsinan stratigraphy and environments in northern Illinois: The Altonian revised: Illinois State Geological Survey Guidebook 19, 177 p.

Berg, R. C., J. P. Kempton, and A. N. Stecyk, 1984, Geology for planning in Boone and Winnebago Counties: Illinois State Geological Survey Circular 531, 69 p.

Berg, R. C., J. P. Kempton, and K. Cartwright, 1984, Potential for contamination of shallow aquifers in Illinois: Illinois State Geological Survey Circular 532, 30 p.

Bergstrom, R.E., 1970, Geology for planning at Crescent City: Illinois State Geological Survey Environmental Geology Notes 36, 15 p.

Bergstrom, R. E., K. Piskin, and L. R. Follmer, 1976, Geology for planning in the Springfield-Decatur region, Illinois: Illinois State Geological Survey Circular 497, 76 p.

Gross, D. L., 1970, Geology for planning in De Kalb County, Illinois: Illinois State Geological Survey Environmental Geology Notes 33, 26 p.

Hackett, J. E., and M. R. McComas, 1969, Geology for planning in McHenry County: Illinois State Geological Survey Circular 438, 29 p.

Hines, J. K., 1986, Siting the superconducting super collider in northeastern Illinois: Environmental Screening Atlas: Illinois State Geological Survey, a division of the Illinois Department of Energy and Natural Resources, 96 p.

Hunt, C. S., and J. P. Kempton, 1977, Geology for planning in De Witt County, Illinois: Illinois State Geological Survey Environmental Geology Notes 83, 42 p.

Jacobs, A. M., 1971, Geology for planning in St. Clair County, Illinois: Illinois State Geological Survey Circular 465, 35 p.

Kempton, J. P., 1981, Three-dimensional geologic mapping for environmental studies in Illinois: Illinois State Geological Survey Environmental Geology Notes 100, 43 p.

Kempton, J. P., and K. Cartwright, 1984, Three-dimensional geologic mapping: A basis for hydrogeologic and land-use evaluations: Bulletin of the Association of Engineering Geologists, p. 317–335.

Kempton, J. P., J. E. Bogner, and K. Cartwright, 1977, Geology for planning in northeastern Illinois VIII, Regional Summary: Illinois State Geological Survey open file report, 71 p.

Kempton, J. P., W. J. Morse, and A. P. Visocky, 1982, Hydrogeologic evaluation of sand and gravel aquifers for municipal groundwater supplies in east-central Illinois: Illinois State Geological Survey and Illinois State Water Survey Cooperative Groundwater Report 8, 59 p.

Kempton, J. P., R. W. Ringler, P. C. Heigold, K. Cartwright, and V. L. Poole, 1981, Groundwater resources of northern Vermilion County, Illinois: Illinois State Geological Survey Environmental Geology Notes 101, 36 p.

Kolata, D. R., and A. Graese, 1983, Lithostratigraphy and depositional environments of the Maquoketa Group (Ordovician) of northern Illinois: Illinois State Geological Survey Circular 528, 49 p.

Larsen, J. I., 1973, Geology for planning in Lake County, Illinois: Illinois State Geological Survey Circular 481, 41 p.

Le Seur, L., 1985, Geohydrology of ground-water contamination, *in* An Assessment of Ground-Water Quality and Hazardous Substance Activities in Illinois with Recommendations for a State-wide Monitoring Strategy: Illinois State Water Survey Contract Report 367, p. 17–45.

Lineback, J. A., 1979, Quaternary deposits of Illinois: Illinois State Geological Survey map, scale 1:500,000.

McComas, M. R., 1968, Geology related to land-use in the Hennepin region: Illinois State Geological Survey Circular 422, 24 p.

McComas, M. R., K. C. Hinkley, and J. P. Kempton, 1969, Coordinated mapping of geology and soils for land-use planning: Illinois State Geological Survey Environmental Geology Notes 29, 11 p.

Miller, J. R., R. C. Berg, T. M. Johnson, and H. A. Wehrmann, 1985, Siting a low-level radioactive waste disposal facility in Illinois: State-wide criteria: Illinois Department of Nuclear Safety, 27 p.

Piskin, K., and R. E. Bergstrom, 1975, Glacial drift in Illinois: Thickness and character: Illinois State Geological Survey Circular 490, 35 p.

Willman, H. B., 1967, Geologic map of Illinois: Illinois State Geological Survey map, scale 1:500,000.

Willman, H. B., and J. C. Frye, 1970, Pleistocene stratigraphy of Illinois: Illinois State Geological Survey Bulletin 94, 204 p.

Willman, H. B., E. Atherton, T. C. Buschbach, C. Collinson, J. C. Frye, M. E. Hopkins, J. A. Lineback, and J. A. Simon, 1975, Handbook of Illinois Stratigraphy: Illinois State Geological Survey Bulletin 95, 261 p.

Willman, H. B., and D. R. Kolata, 1978, The Platteville and Galena Groups in northern Illinois: Illinois State Geological Survey Circular 502, 75 p.

OPEN FILE (UNPUBLISHED) MAPS

Most unpublished maps exist as an "open file;" that is, request for copies can be honored, but the maps are preliminary and not yet formally published. Contact the Illinois State Geological Survey to obtain a copy of these maps.

Anderson, R. C., and T. M. Johnson, Stack-unit map of Henry County: Illinois State Geological Survey unpublished map, scale 1:62,500.

Ball, T. R., and L. R. Follmer, stack-unit map of Marion, Fayette and Effingham Counties, Illinois: Illinois State Geological Survey unpublished map, scale 1:62,500.

Berg, R. C., and J. P. Kempton, Stack-unit map of Kankakee County, Illinois: Illinois State Geological Survey unpublished map.

Johnson, W. H., Stack-unit map of Vermilion County, Illinois: Illinois State Geological Survey unpublished map, scale 1:62,500.

Kempton, J. P., Stack-unit maps of Lee and Bureau Counties: Illinois State Geological Survey unpublished maps, scale 1:62,500.

Killey, M. M., Stack-unit map of Champaign County, Illinois: Illinois State Geological Survey unpublished map, scale 1:62,500.

McKay, E. D., J. M. Fox, J. K. Hines, and M. M. Killey, Stack-unit map of Madison County, Illinois: Illinois State Geological Survey unpublished map, scale 1:62,500.

Plate 1

Stack-Unit Map of Northern Illinois

(to a depth of 15 m (49.3 ft))

by
Richard C. Berg and John P. Kempton
1987

.7 ft)

	6–15 m (19.7–49.3 ft) of surface	0–6 m (0–19. of surface
Teneriffe Silt	**1**	1
Pearl Fm (includes Hagarstown Mbr)	**2**	2
Glasford Fm, silty and clayey diamictons	**3**	3
Glasford Fm, loamy and sandy diamictons	**4**	4
Sand and gravel within Glasford Fm:	**5**	5
within 6 m (19.7 ft) of surface	**6**	6
between 6–15 m (19.7–49.3 ft) of surface	**7**	7
Wolf Creek Fm (mainly diamictons)	**( )**	
Mounds gravel and related units		
Cretaceous sediments, silts, sands, etc.		( )
Surface mines/man-made land		
Continuous throughout map area but less than 6 m (19.7 ft) thick in some areas. If unit is lowermost, it may not be present above the 15 m (49.3 ft) depth, but generally lies at or just below 15 m (49.3 ft)		
Not continuous throughout map area. If unit is lowermost, it may not be present above the 15 m (49.3 ft) depth, but generally lies at or just below 15 m (49.3 ft)		

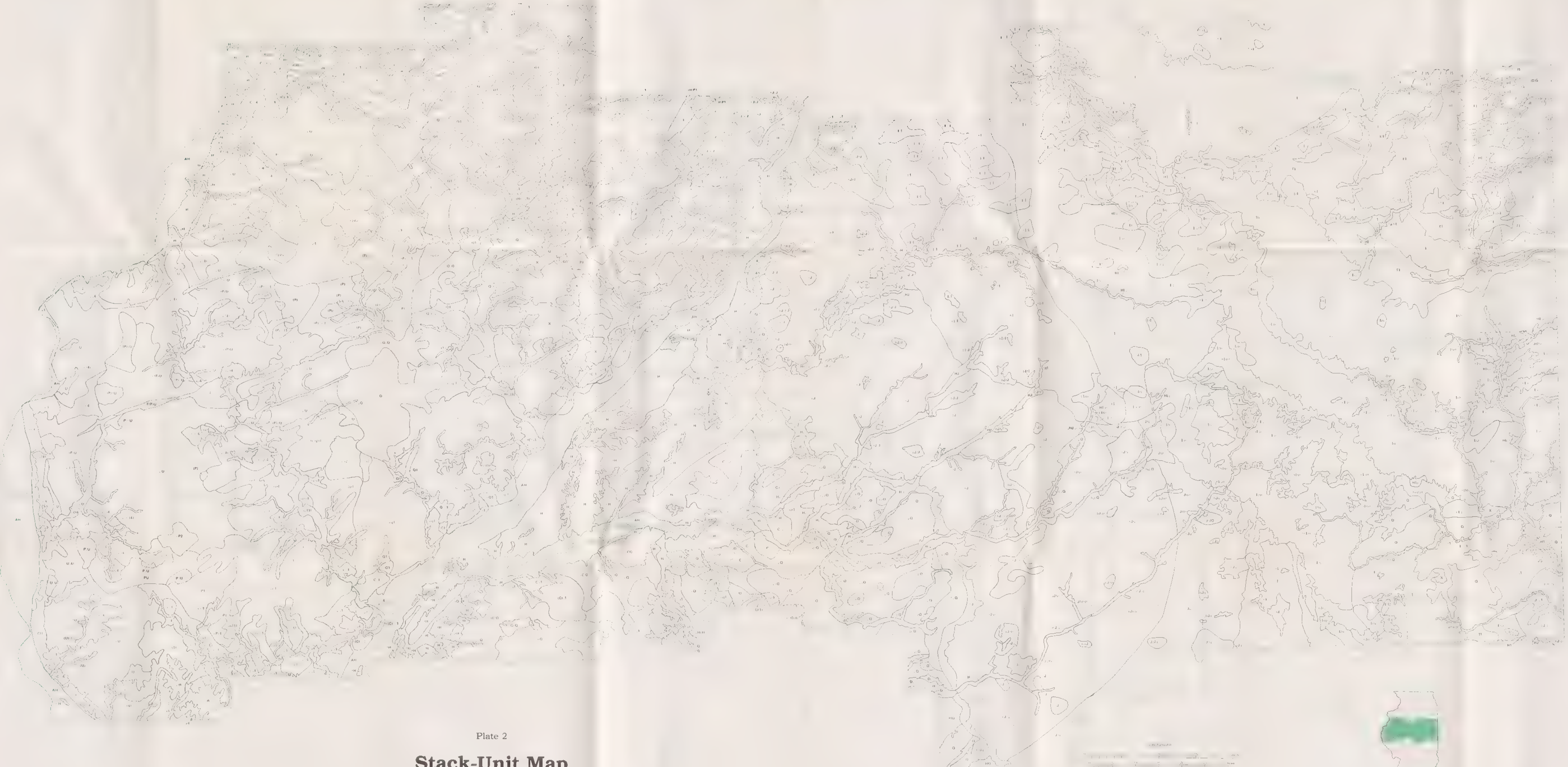

Plate 2

Stack-Unit Map of Central Northern Illinois

(to a depth of 15 m (49.3 ft))

by

Richard C. Berg and **John P. Kempton**

1987


R8W
7W
PIKE
T
4
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(C)4
c4
c(u)4
a4
cu(4)
c(u)4
cu1
cu1
cu4
(C)4
c(u)4
a4
(C)(u)4
a4
CU
(C)(u)4
(C)4
a4
AH

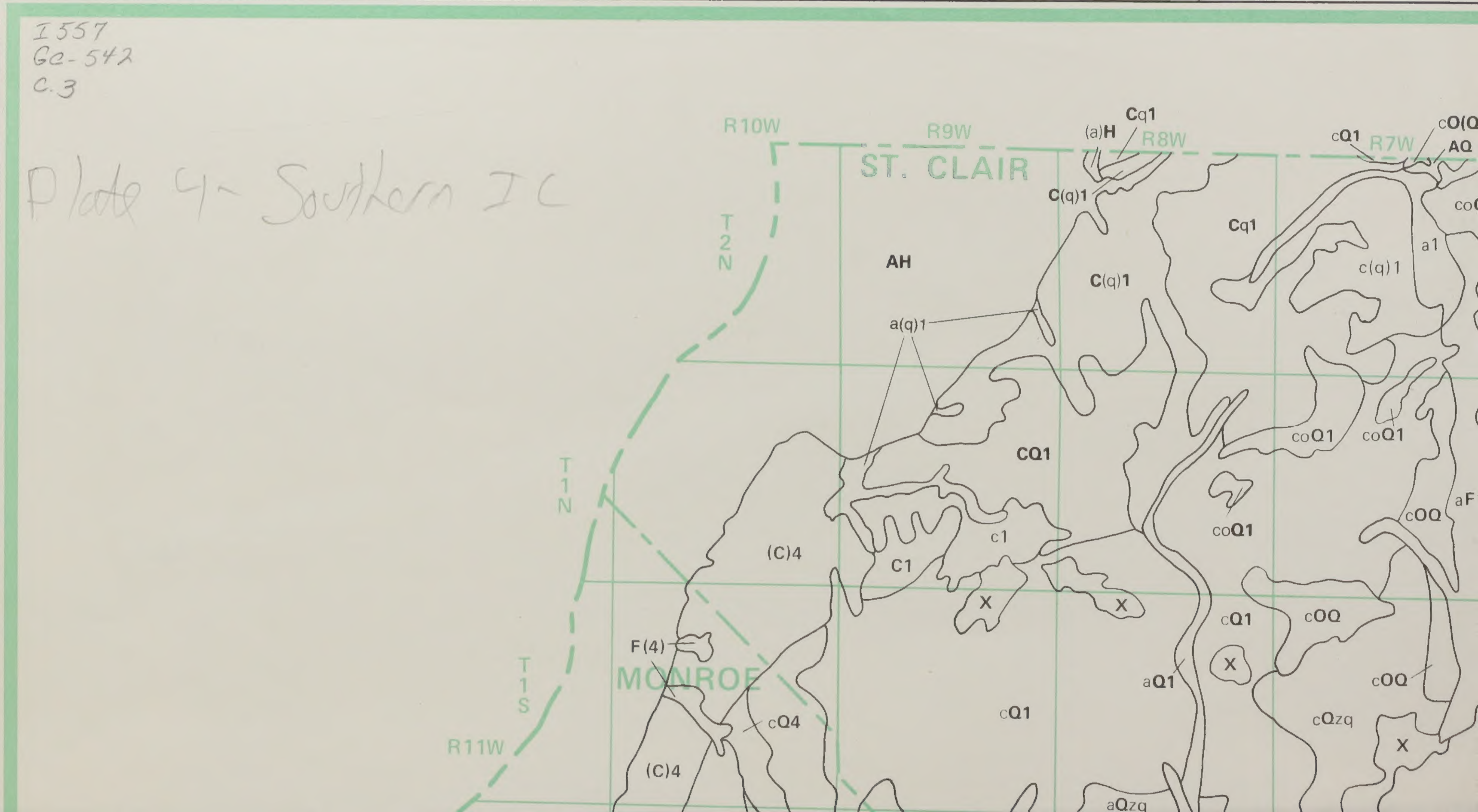
Plate 3

Stack-Unit Map of Central Southern Illinois

(to a depth of 15 m (49.3 ft))

by
Richard C. Berg and John P. Kempton
1987

Plate 4 - Southern IC



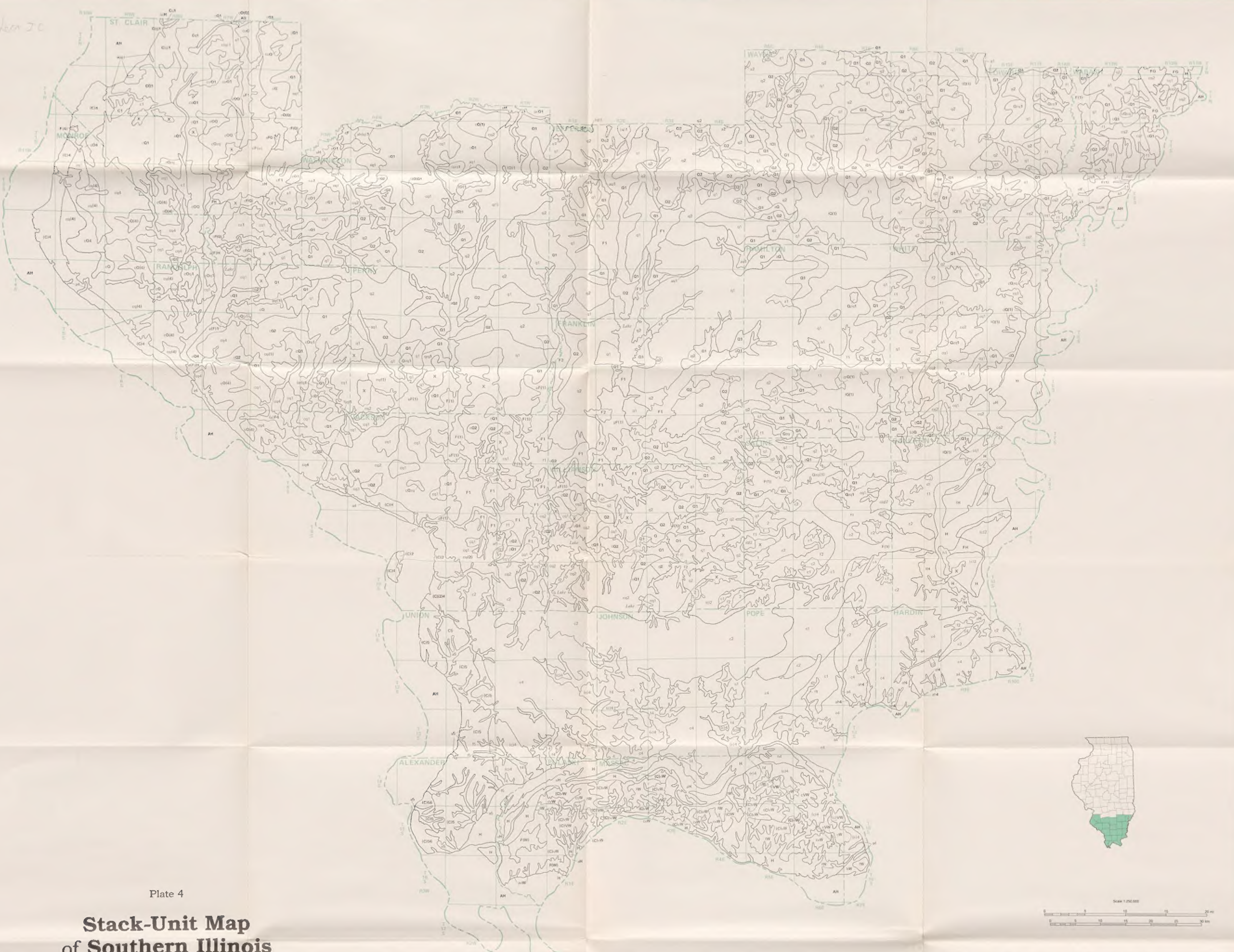


Plate 4

Stack-Unit Map of Southern Illinois

(to a depth of 15 m (49.3 ft))

by

Richard C. Berg and **John P. Kempton**

1987

Scale 1:250,000

0 5 10 15 20 mi

0 5 10 15 20 25 30 km

Interpretation of stack-unit symbols
c(q)/(r)1

Peoria Loess and Roxana Silt <6 m (19.7 ft) thick, overlying discontinuous Glasford Fm silty and clayey diamictons, <6 m (19.7 ft) thick, overlying a discontinuous sand and gravel within the Glasford Fm that is <6 m (19.7 ft) thick and within 6 m (19.7 ft) of the surface, overlying Pennsylvanian shales between a depth of 6 m (19.7 ft) and 15 m (49.3 ft)

Map symbols: Material >6 m (19.7 ft) thick	Map symbols: Material <6 m (19.7 ft) thick	Nonlithified and semilithified materials
A	a	Cahokia Alluvium
B	b	Richland Loess
C	c	Peoria Loess and Roxana Silt
D	d	Parkland Sand
E	e	Grayslake Peat
F	f	Equality Fm, Carmi Mbr
G	g	Equality Fm, Dolton Mbr
Y	y	Peyton Colluvium
H	h	Henry Fm
I	i	Wedron Fm, silty and clayey diamictons
J	j	Wedron Fm, loamy and sandy diamictons
K		Sand and gravel within Wedron Fm
	k	within 6 m (19.7 ft) of surface
	z	between 6–15 m (19.7–49.3 ft) of surface
L	l	Winnebago Fm, mainly sandy diamictons
M		Sand and gravel within Winnebago Fm
	m	within 6 m (19.7 ft) of surface
	z	between 6–15 m (19.7–49.3 ft) of surface
N	n	Teneriffe Silt
O	o	Pearl Fm (includes Hagarstown Mbr)
P	p	Glasford Fm, silty and clayey diamictons
Q	q	Glasford Fm, loamy and sandy diamictons
R		Sand and gravel within Glasford Fm
	r	within 6 m (19.7 ft) of surface
	z	between 6–15 m (19.7–49.3 ft) of surface
U	u	Wolf Creek Fm (mainly diamictons)
V	v	Mounds gravel and related units
W	w	Cretaceous sediments, silts, sands, etc.
X		Surface mines/man-made land
( )		Continuous throughout map area but less than 6 m (19.7 ft) thick in some areas. If unit is lowermost, it may not be present above the 15 m (49.3 ft) depth, but generally lies at or just below 15 m (49.3 ft)
	( )	Not continuous throughout map area. If unit is lowermost, it may not be present above the 15 m (49.3 ft) depth, but generally lies at or just below 15 m (49.3 ft)

Map symbols: Between 6–15 m (19.7–49.3 ft) of surface	Map symbols: Between 0–6 m (0–19.7 ft) of surface	Lithified materials
1	1	Pennsylvanian rocks, mainly shales
2	2	Pennsylvanian rocks, mainly sandstones
3	3	Mississippian rocks, mainly shales
4	4	Mississippian rocks, mainly limestones, some sandstones
5	5	Silurian and some Devonian rocks, mainly dolomite
6	6	Ordovician rocks, mainly shale (Maquoketa Group)
7	7	Ordovician and Cambrian rocks, mainly dolomite, some sandstone
( )		May not be present above the 15 m (49.3 ft) depth, but generally lies at or just below 15 m (49.3 ft)
	( )	May not be continuous in the map area within 6 m (19.7 ft) of surface, but is present between depths of 6 and 15 m (19.7 and 49.3 ft) over a portion of the map area